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LASER-ASSISTED CHEMICAL REACTIONS OF ORGANOMETALLIC
COMPLEXES AT SURFACES(U) HUGHES RESEARCH LABS MALIBU
CALIF CHEMICAL PHYSICS DEPT J E JENSEN 15 FEB 88

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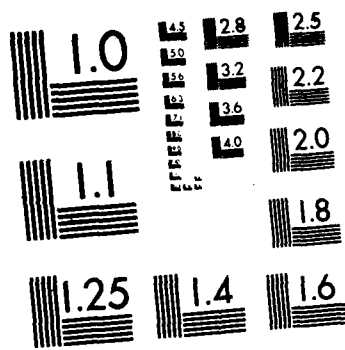
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DOCUMENTATION PAGE

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OMB No. 0704-0188

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1a. REPORT SECURITY CLASSIFICATION Unclassified			1b. RESTRICTIVE MARKINGS N/A		
2a. SECURITY CLASSIFICATION AUTHORITY N/A			3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution unlimited		
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE N/A			5. MONITORING ORGANIZATION REPORT NUMBER(S)		
4. PERFORMING ORGANIZATION REPORT NUMBER(S) Final Report			7a. NAME OF MONITORING ORGANIZATION Office of Naval Research		
6a. NAME OF PERFORMING ORGANIZATION Hughes Research Laboratories		6b. OFFICE SYMBOL (If applicable)	7b. ADDRESS (City, State, and ZIP Code) 800 N. Quincy Street Arlington, VA 22217		
6c. ADDRESS (City, State, and ZIP Code) 3011 Malibu Canyon Road Malibu, CA 90265		9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER N00014-81-C-0642			
8a. NAME OF FUNDING / SPONSORING ORGANIZATION Office of Naval Research		8b. OFFICE SYMBOL (If applicable)	10. SOURCE OF FUNDING NUMBERS		
8c. ADDRESS (City, State, and ZIP Code) 800 N. Quincy Street Arlington, VA 22217		PROGRAM ELEMENT NO. PROJECT NO. TASK NO. WORK UNIT ACCESSION NO.			
11. TITLE (Include Security Classification) Unclassified Laser-Assisted Chemical Reactions of Organometallic Complexes at Surfaces					
12. PERSONAL AUTHOR(S) J. E. Jensen					
13a. TYPE OF REPORT Final Report		13b. TIME COVERED FROM Aug 81 TO Aug 87		14. DATE OF REPORT (Year, Month, Day) 88-2-15	
15. PAGE COUNT 4					
16. SUPPLEMENTARY NOTATION					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP			
19. ABSTRACT (Continue on reverse if necessary and identify by block number)					
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input checked="" type="checkbox"/> SAME AS RPT <input type="checkbox"/> DTIC USERS					
21. ABSTRACT SECURITY CLASSIFICATION Unclassified					
22a. NAME OF RESPONSIBLE INDIVIDUAL Dr. David L. Nelson			22b. TELEPHONE (Include Area Code) (202) 696-4410		22c. OFFICE SYMBOL

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OFFICE OF NAVAL RESEARCH

Contract N00014-81-C-0642

R&T Code No. 413E023

Final Report

Laser-Assisted Chemical Reactions of
Organometallic Complexes at Surfaces

by

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February 1988



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SUMMARY

Objectives

Gallium Arsenide, Aluminum Arsenide, GaAs, AlAs

The objectives of this research program are to investigate laser-assisted chemical reactions involving organometallic complexes for deposition of electronic materials at low temperatures. Specific areas of investigation are to (1) elucidate the kinetics and mechanisms of the photophysical and photochemical processes operative during laser-stimulated dissociation of organometallic complexes and subsequent reaction of the photoproducts with a surface, (2) apply studies of photo-induced processes to the deposition of semiconductors, such as *GaAs, AlAs, and GaAlAs*, and conductors such as *Au*, and (3) establish experimental conditions under which epitaxial growth of the deposited materials can be achieved.

Accomplishments

Gallium Arsenide, Aluminum Arsenide

We have synthesized several new organometallic complexes for use in the investigation of laser-assisted depositions on this program. Complexes containing Ga-As and Al-As bonds have been used in the first photochemical deposition of stoichiometric films of GaAs and [GaAl]As. These studies have demonstrated that laser irradiation parallel to the substrate produces stoichiometric films and that with irradiation perpendicular to the substrate a competition exists between desorption and photodeposition, which adversely affects the stoichiometry of the film.

Using an excimer laser operating at 308 nm (XeCl) we have deposited pure gold films using the volatile gold-containing complex dimethylgold hexafluoroacetoacetate. Deposition rates up to 20 $\mu\text{m/hr}$ on silicon, germanium, GaAs, quartz, and sapphire substrates have been observed with the substrates held at room temperature. Surface analysis (XPS) of these films has shown them to be free of any contaminants from the ligands or other sources. To our knowledge this is the first report of the deposition of high quality pure gold films by a low temperature photochemical process.

Additionally, we have developed and applied laser-induced fluorescence and multiphoton ionization spectroscopy for real-time, non-intrusive detection of gas-phase intermediates and products generated during beam-assisted chemical reactions. These results have enabled us to detect Si, Ga, As, and Te atoms generated by photodissociation of organometallic source materials. These studies have provided us with important information about the photochemistry and dissociation dynamics of organometallic compounds used as source materials for the photochemical deposition of semiconductors.

PRESENTATIONS, PUBLICATIONS AND PATENTS

Presentations

1. "Excimer Laser-Induced Reactions of Thin Solid Films of Gallium-Arsenic Molecular Complexes" J.E. Jensen and G.L. Olson, Mater. Res. Soc., Boston, MA (Dec. 1984).
2. "Laser-Assisted Deposition of Metals and Semiconductors" L.W. Tutt and J.E. Jensen, Southern California Photochemistry Conference, Lake Arrowhead, CA (June 1986).

3. "Excimer Laser-Assisted Deposition of GaAs, AlAs, and [Al,Ga]As on Ge<100> Surfaces From Donor-Acceptor Complexes" J.J. Zinck, P.D. Brewer, J.E. Jensen, G.L. Olson, and L.W. Tutt, Mater. Res. Soc., Boston, MA (Dec. 1986).
4. "Two-Photon Laser-Induced Fluorescence and '2+1' Multiphoton Ionization of Silicon Atoms" P.D. Brewer, Conf. on Lasers and Electroopt., Baltimore, MD (Apr. 1987).
5. "Alkyl Telluride UV Photodissociation Dynamics" P.D. Brewer, J.J. Zinck, J.E. Jensen, L.W. Tutt, and G.L. Olson, Mater. Res. Soc., Boston, MA (Dec. 1987).

Publications

1. J.J. Zinck, P.D. Brewer, J.E. Jensen, G.L. Olson, and L.W. Tutt, Mater. Res. Soc. Symp. Proc. **75**, 233 (1987).
2. P.D. Brewer, Chem. Phys. Lett. **136**, 557 (1987)
3. P.D. Brewer, Chem. Phys. Lett. **141**, 301 (1987)
4. J.J. Zinck, P.D. Brewer, J.E. Jensen, G.L. Olson, and L.W. Tutt, Appl. Phys. Lett., submitted.
5. P.D. Brewer, J.E. Jensen, G.L. Olson, L.W. Tutt, and J.J. Zinck, (Alkyl Telluride UV Photodissociation Dynamics) 1988, submitted to Mater. Res. Soc. Symp. Proc.
6. L.W. Tutt, W.J. Gignac, and J.E. Jensen, (The Excimer Laser-Assisted Deposition of Gold From Dimethylgold Hexafluoroacetoacetate) 1988, in preparation.
7. L.W. Tutt and J.E. Jensen, (Mechanism of the Photodissociation of Dimethylgold Hexafluoroacetoacetate) 1988, in preparation.

Patents

1. Method For Forming Gallium Arsenide From Thin Solid Films of Gallium-Arsenic Complexes, filed 20 November 1984; issued 10 June 1986, patent #4,594,264.
2. Low Temperature Photochemical Deposition of High Purity Gold Films, invention disclosure filed 15 December 1987, application in preparation.

PERSONNEL

The following Hughes Research Laboratories personnel contributed to the research program:

Peter D. Brewer
 John E. Jensen
 Gregory L. Olson
 Lee W. Tutt
 Jenna J. Zinck

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